

DEVELOPMENT AND PERFORMANCE VALIDATION OF AN OUTDOOR AUTONOMOUS NAVIGATION FRAMEWORK FOR UNMANNED GROUND VEHICLES

Department of Automation And Robotics

Members: Shrigovinda T Kulkarni - 01FE23BAR047, Tanmay Hiremath - 01FE23BAR030, Bhoomika Hotagi - 01FE23BAR035, P Nisar Ahmed - 01FE24BAR409

Mentor: Dr. Rakesh P. Tapaskar Coordinators: Prof. Girish Karikatti, Prof. Channava Soori

Problem Statement

Manual monitoring in hazardous environments is inefficient and poses significant safety risks. Existing solutions are expensive and limited in mobility. This project addresses these challenges by developing a low-cost autonomous UGV for remote surveillance, intelligent navigation, and real-time data collection.

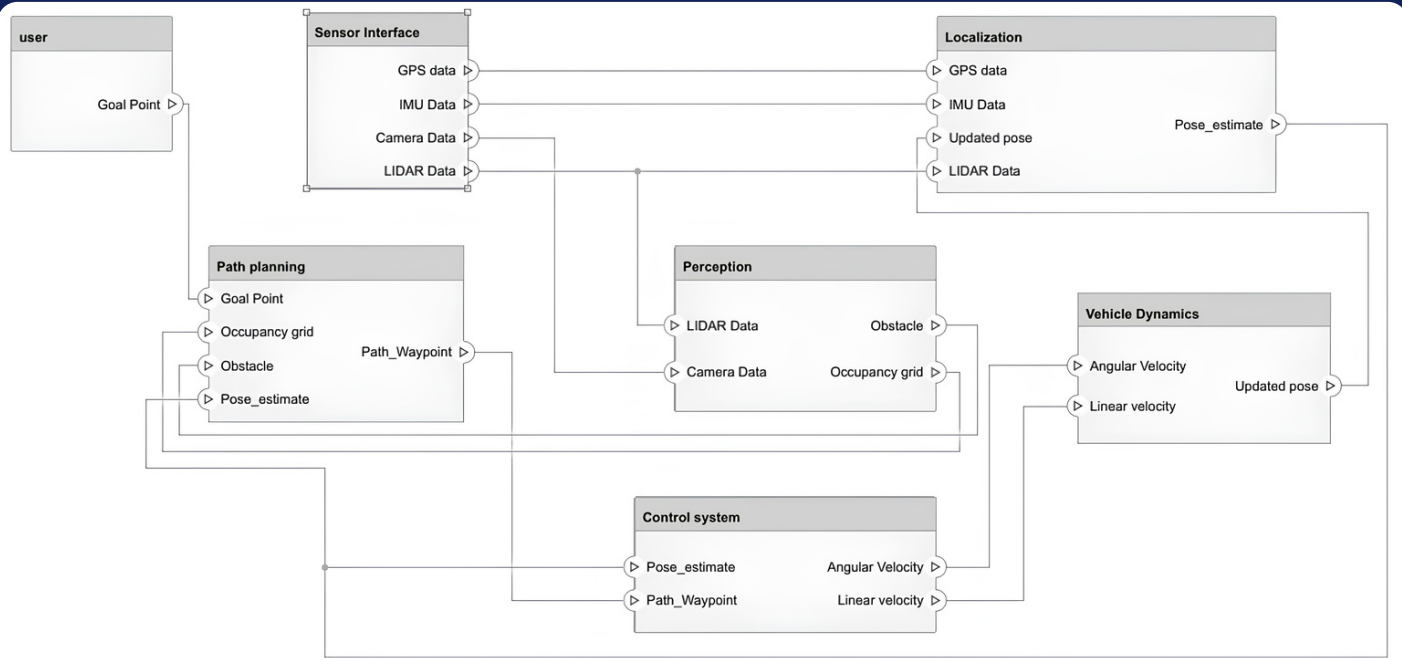
Functional Requirement

- The UGV shall provide mobility in forward, reverse, left, and right directions using four hub motors.
- The UGV shall support autonomous navigation between predefined waypoints.
- The system shall detect obstacles using LiDAR sensor during navigation.
- The system shall perform obstacle avoidance during autonomous operation.

Non-Functional Requirement

- The UGV shall operate at speeds between 0.5 m/s and 1.5 m/s on flat terrain.
- The motor drive system shall operate within input voltage range of 31–36 V.
- The system shall operate using a battery capable of minimum 30 minutes continuous operation.
- The boost converter shall provide 36 V output within $\pm 5\%$ tolerance.

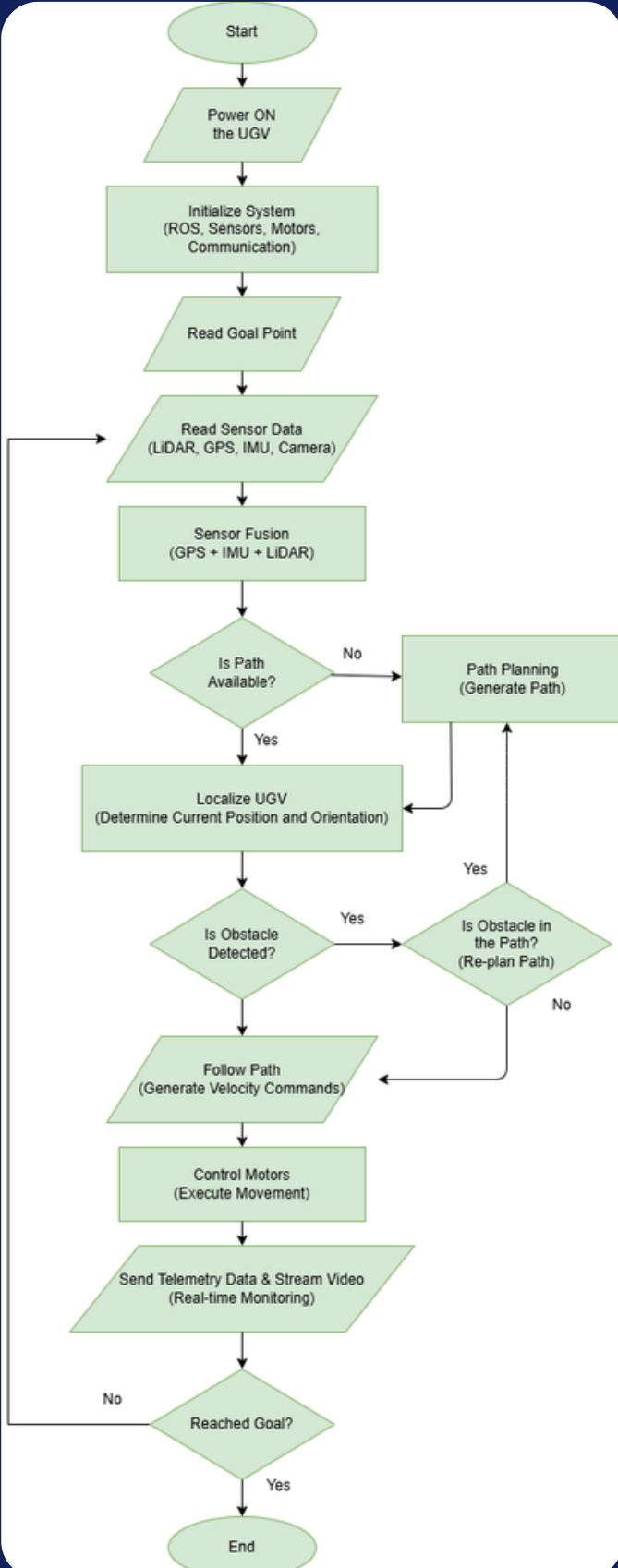
Functional Architecture



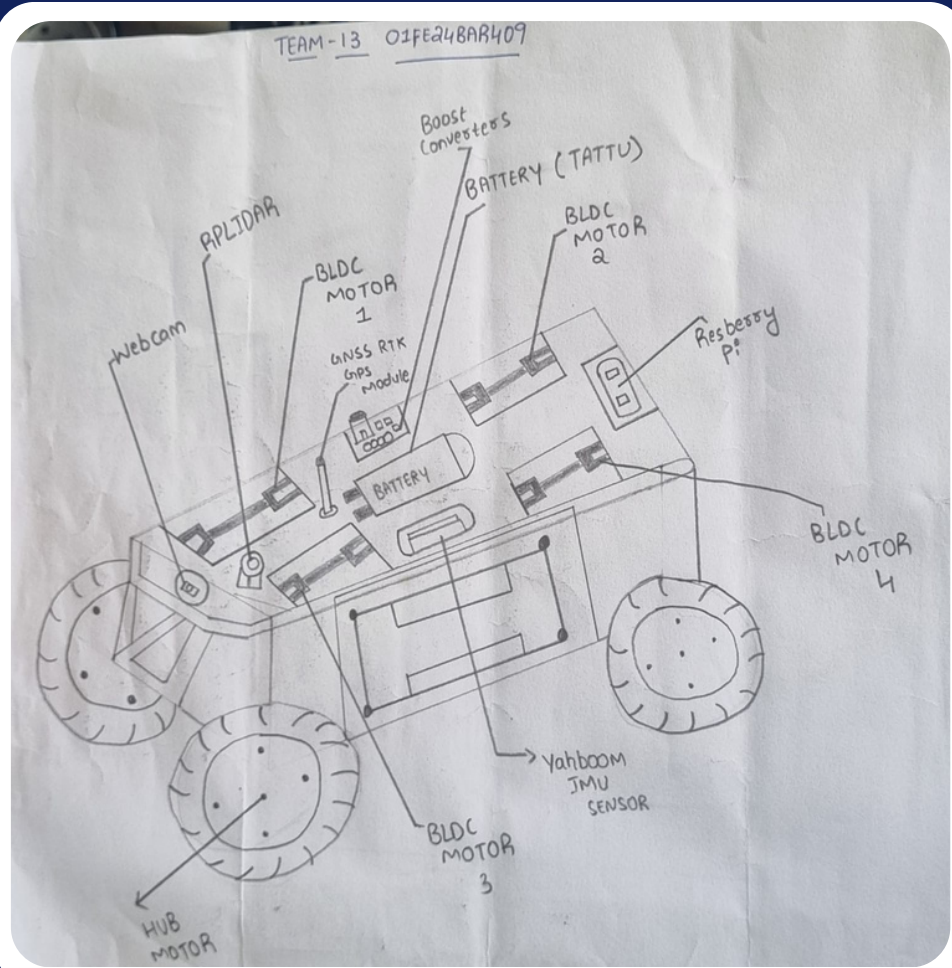
Pugh Chart

Criteria	Weight	C1	C2	C3	C4
Structural Stability	5	0	0	+	+
Ease of Fabrication	4	+	0	0	0
Component Mounting Space	5	—	—	+	0
Sensor Placement Suitability	5	0	+	+	0
Weight Distribution	4	—	0	+	0
Outdoor Terrain Adaptability	5	—	0	+	0
Ease of Maintenance	3	+	0	+	0
Wiring / Integration Simplicity	4	0	—	+	0
Expandability / Modularity	5	—	0	+	0
Overall Feasibility	5	0	0	+	0
Total Weighted Score	45	-12	-4	41	5

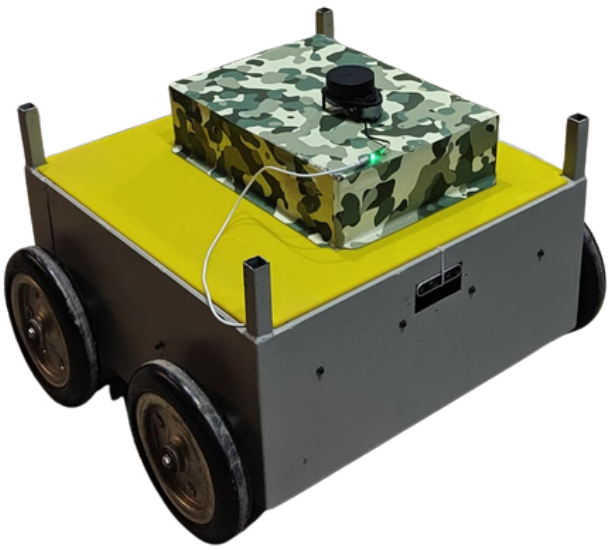
Flow Chart



Finalized Concept



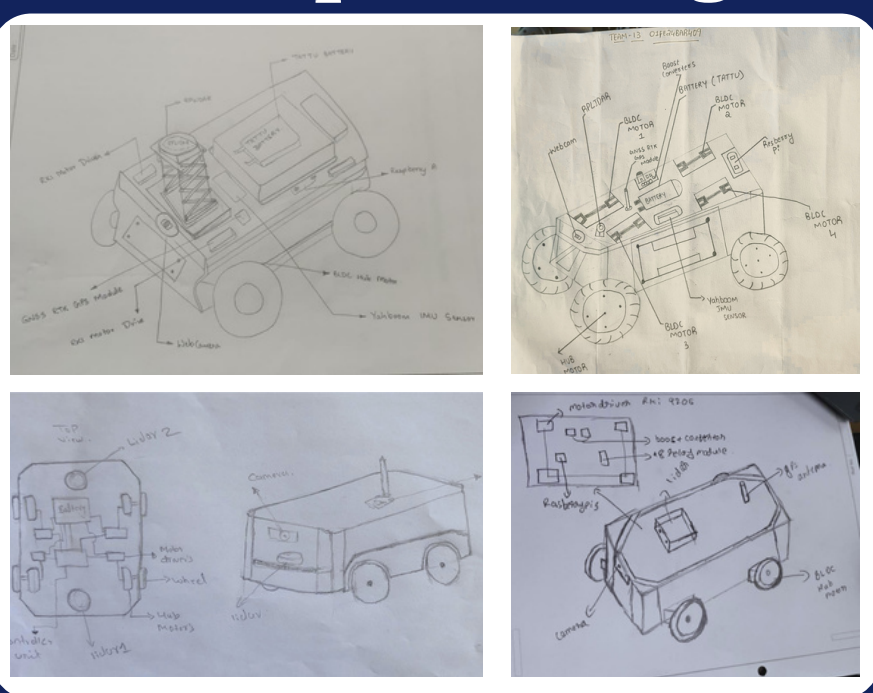
Final Product



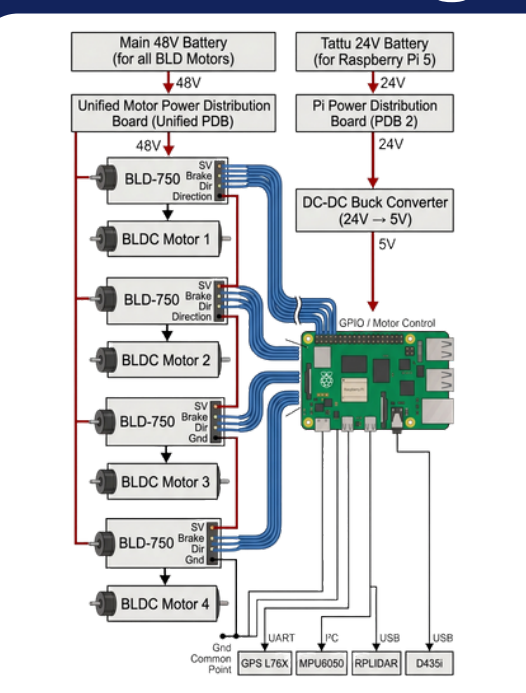
Bill Of Material

Sl. No.	Component	Specifications	Qty.	Unit Price (₹)	Total (₹)
1	GPS Module	GPS L76X	1	2,338	2,338
2	IMU Sensor	MPU6050	1	154	154
3	BLDC Hub Motor	36 V	4	5,990	23,960
4	BLD-750 Motor Driver	750 W BLDC Driver	4	6,000	24,000
5	Raspberry Pi 5	16 GB RAM	1	34,049	34,049
6	TATTU Battery	30,000 mAh	1	38,525	38,525
7	RPLIDAR	A1M8 LiDAR	1	7,992	7,992
8	Intel RealSense D435i	Depth Camera	1	26,967	26,967
9	Buck Converter	DC-DC 5 V, 5 A	1	549	549
10	Acrylic Sheet	400 × 600 × 5 mm	1	900	900
11	Memory Card	128 GB microSD	1	990	990
12	UGV Chassis	400 × 600 × 20 mm	1	6,500	6,500
13	Nuts & Bolts	M12 × 50 mm	40	17	680
Grand Total					₹167,604

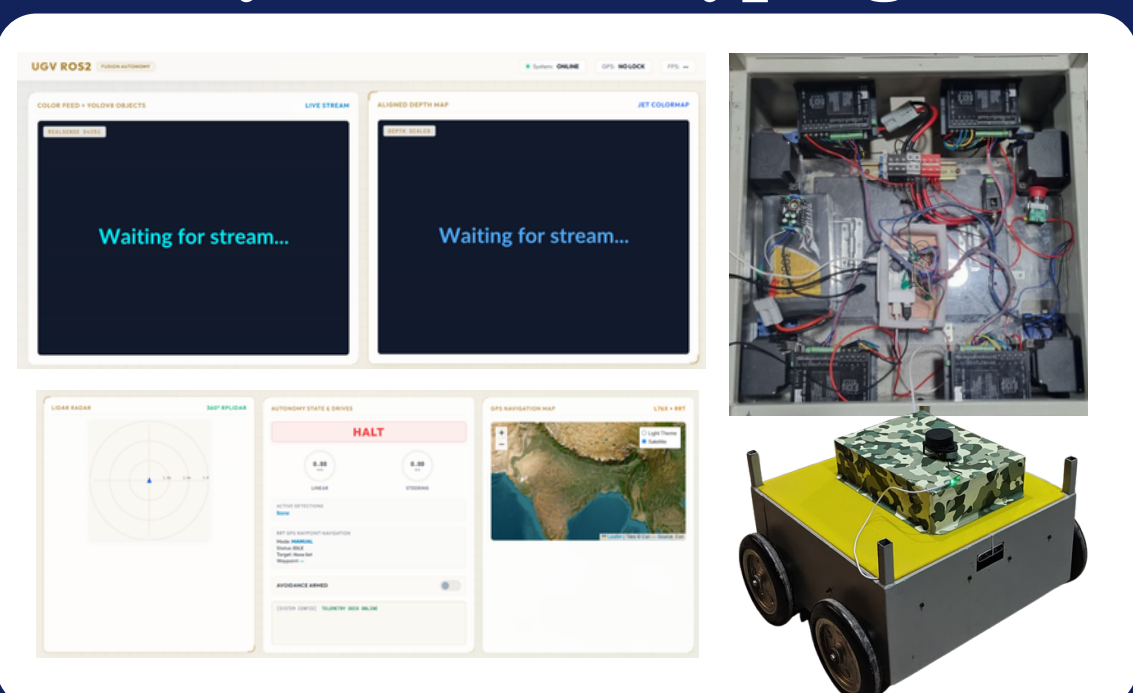
Conceptual Design



Circuit Design



Physical Prototyping



Portfolio Scan QR

